Preliminary Note on the Occurrence of a Chromite-Bearing Rock in the Basalt at the Pennant Hills Quarry near Parramatta.

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The basalt quarry at the Pennant Hills has been described by Mr. C. S. Wilkinson, F.G.S., the late Government Geologist.* With reference to this quarry Mr. Wilkinson states *(loc. cit.)*:—"It is an immense excavation from which the road metal is said to have been taken for over fifty years. The rock consists of a dense but jointed basalt, containing small fragments of other rocks and some large masses of coaly shale, from which it would appear that this spot is the site of an ancient volcanic point of eruption." Subsequent examination of this quarry by ourselves, inclines us to confirm Mr. Wilkinson's opinion as to its having probably at one time formed part of a volcano, or at any rate having been definitely related to some volcanic outburst.

General Geological Features.

The Pennant Hills Quarry is distant about three miles north-easterly, from Parramatta, and about one and a-half miles westerly from Eastwood Railway Station on the Northern Line. The quarry has been worked intermittently for road metal, for which purpose the rock there is well adapted, for about sixty-three years, during which time an excavation has been formed about three hundred feet long, one hundred and fifty feet wide and seventy feet deep, which affords an excellent geological section.

The rock quarried is seen to be an eruptive mass of basalt apparently of elongated oval shape, and more or less surrounded

* Annual Report of the Department of Mines for 1879, page 218, Appendix A.

by the sedimentary rocks, which it has intruded. No distinct evidence however was obtained to prove that the eruptive rock was shut off in every direction by sedimentary rock, and it is probable that it is prolonged in the form of tongue-like apophyses or as dykes, in one or more directions. This supposition is confirmed by the statement made to us by a local observer to the effect that at a distance of about one and a-half miles from the Pennant Hills Quarry a rock occurred, which he considered similar to the chromite-bearing rock, which forms the subject of this paper. The sedimentary rocks seen at the quarry belong to the Wianamatta Shales, the uppermost division of the Hawkesbury Series, and are admitted to be probably of Triassic Age. The junction line however of the under surface of the Wianamatta Shale with the top of the underlying Hawkesbury Sandstone cannot be far below the level of the bottom of the quarry, as a comparison of the latter level with that of the junction line between these two formations, as seen in the neighbouring road cuttings proves. It is possible that the deepest portion of this quarry is already below the junction line of the Wianamatta Shale with the Hawkesbury Sandstone, but as this portion of the quarry is situated wholly in the eruptive rock, this question cannot be settled at present. The section on the east side of the quarry shows that the eruptive mass of basalt has distinctly intruded the Wianamatta Shales, the line of junction between the two rocks being almost invariably characterised by the presence of a "crush-breccia," composed of angular fragments of Wianamatta Shale, bleached to a light grey colour, and otherwise altered by the dark grey to black eruptive rock, in which they are imbedded.

In addition to the angular fragments of Wianamatta Shale, forming the crush-breccias, there are numerous enclosures in the basalt (upon the eastern and south-eastern faces of the quarry), of other rocks, including lumps of clay shale, pieces of Hawkesbury Sandstone converted into quartzite, and two varieties of eruptive rocks, both of which are foreign to the district, and one of which at least is not known to occur elsewhere in New South

Wales. The last mentioned rock, which contains chromite, occurs in the form of irregularly rounded blocks, the rounded character of which is probably not due to the mechanical action of water, but rather to a partial fusion of the rock in the magma of the originally molten basalt, which by corroding the edges and angles more than the other portions would rapidly convert angular fragments into rounded, just as mineral splinters become rounded during the process of fusion in a borax head before the blowpipe. These blocks vary in diameter from a few inches up to about twenty inches. As they decompose less readily than the basalt they weather out from it, and can be readily separated from the matrix, when the latter is much decomposed, but less decomposed portions of the matrix are found to adhere very tightly to the blocks, and in such cases small fragments of the partially fused blocks appear to be present in the basalt near its contact with the enclosed blocks.

Macroscopic Characters.

At first sight there appear to be two distinct varieties of chrome-bearing rock present, the one a hard dense grey rock, like a very fine grained granite or felstone, which on freshly broken surfaces shows small particles of a jet-black mineral, with minute crystals of pyrites, and what appears to be small greenish stains, the other a greenish-grey rock, showing on freshly fractured surfaces patches of a green mineral, at first presumed to be malachite, intermixed with grey to brownish-grey material. A detailed examination however of these two varieties of rock shows that they probably belong to one and the same type, the difference in their general appearance being due partly to the relative amount of decomposition, which they have respectively undergone, and partly to the comparative variety or abundance of the mineral which has yielded the greenish decomposition products, and which was probably a chrome-bearing diallage, similar to that about to be described.

One block of the chromite-bearing diallage and felspar with chromite passes gradually at the periphery into an external zone about three inches in thickness composed of the greenish-brown

rock. In some cases the central portions of the blocks are more decomposed than the external, and exhibit very clearly the granular structure of the rock.

Some of the chromite-bearing fragments, which are much decomposed, are rusty-brown in colour mottled with green, the former tint being due to the conversion of the iron pyrites into hydrated ferric oxide.

In one fragment, the black particles of chromite appear to be aggregated in parallel bands. Some of the fragments are coated with a thin layer of calcite, and the same mineral is found traversing the rock in the form of minute veins formed by segregation or infiltration.

Hardness.—The undecomposed portions of the rock, which are chifly felspar, can be scratched with a steel penknife only with great difficulty, and the hardness must be nearly 7. The chromite has a hardness of between 5 and 6, and the green mineral a hardness of about 3.

Specific Gravity.—The specific gravity of the less decomposed fragments comparatively free from the green mineral and from diallage, but comparatively rich in chromite, was found to be 2·92, while that of a more decomposed fragment containing less chromite and more of the green mineral was found to be 2·76. The specific gravity, therefore, decreases in proportion to the extent of the decomposition. The specific gravity of the felspar approaches that of anorthite, being about 2·7, and that of the green mineral is slightly less, while the specific gravity of the diallage is about 3.

In structure the rock is crystalline granular, felspar predominating and forming the grey coloured areas. The chromite occurs in grains from $\frac{1}{40}$ of an inch up to as much as $\frac{1}{6}$ of an inch in diameter. The diallage crystals are about half an inch in longest diameter, and the green patches representing the decomposed diallage are approximately of the same size, but show a tendency to become blended with one another owing to the spreading of the colouring ingredient. The iron pyrites for the most part is of microscopic dimensions.

Blowpipe characters.—The diallage is slightly fusible and reacts strongly for chromium in the borax head. The green mineral also reacts strongly for chromium. The chromite was found to be almost infusible except at the ends of very thin splinters. The felspar is slightly fusible, and tested by Szabo's method did not give any potash reaction. From this circumstance, taken in conjunction with the fact that the rock effervesces somewhat briskly in hydrochloric acid, and that the specific gravity of the mineral approaches that of anorthite, it is probable that the felspar belongs to the lime or lime-soda series.

Microscopic Structure.

Thin sections of this rock when viewed under the microscope have shown it to be a holocrystalline granular aggregate of felspar and chromite, with iron pyrites and a greenish mineral, the green colouration of which is due to the presence of chromium.

Constituents.—The felspar, which is greyish-white to colourless, and belongs probably to the lime-soda series, is present in the form of granular particles with polygonal outline, which are either traversed by numerous irregular cracks, such as are common in the felspars of troctolite, or show a zig-zag banding probably produced later than the formation of the felspar. The felspars especially those which exhibit the zig-zag banded structure, include a fine dust of iron pyrites, which is frequently disposed in layers following the banding. In some cases curious dendritic forms, resembling cabbage-stalks, of iron pyrites bisect the angles of the folds.

The chromite appears in thin sections as more or less translucent reddish-brown grains of irregular outline, having a very high index of refraction. These seem to occupy a central position from which radiate out in all directions lines which represent the edges of the felspar granules. The crystals are traversed by irregular cracks, no true cleavage planes being present.

The green particles, which seem to represent some decomposition mineral containing chromium, are of a dull pale green colour, and

in places show a fibrous structure. The green mineral appears to be an altered diallage. The evidence upon which this statement is based, has been derived from one of the sections, which shows the transition from a diallage to that of the green mineral under consideration.

Diallage.

This mineral occurs in grains of irregular outline having a well marked parallel structure due to prismatic intergrowth, which in the coarseness of its structure resembles that of bronzite rather than that of typical diallage. The colour by transmitted light is a pale yellowish-green. The granules show cleavage cracks and microscopic inclusions, and a well-marked parting parallel to the orthopinacoid. Cleavage flakes taken parallel to this parting have straight exstinction, and exhibit the excentric emergence of an optic axis in convergent polarised light, a feature specially characteristic of diallage, and this admits of the determination of the optical sign of the mineral as positive. The double refraction is high, as indicated by the polarization colours, and the index of refraction is also high. The majority of the sections give oblique exstinction up to angles of 39°.

Note on the Occurrence of a Calcareous Sandstone Allied to Fontainebleau Sandstone at Rock Lily, near Narrabeen.

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Calcareous Sandstone has previously been recorded as occurring in the Tomago Series of East Maitland, the calcite being crystallised out in the mass of the sandstone, and also in rocks of the